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TRANSPORTATION
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INVENTORY OF SPECIAL FACILITIES FOR HIGHWAY RESEARCH IN ARIZONA

Special Report

Prepared by:

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October 1991

Prepared for:

Arizona Department of Transportation
206 South 17th Avenue
Phoenix, Arizona 85007
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

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16. Abstract In June, 1991 the Arizona Transportation Research Center (ATRC) was asked to conduct a survey for the Federal Highway Administration by the Transportation Research Board and the American Association of State Highway and Transportation Officials. This survey was to identify unique research facilities available for highway research. Computer systems were excluded. Another key criteria was that the site had to have an equipment replacement value of \$500,000 or more. The criteria for selection by the Federal Highway Administration is given in Appendix A. Potential research sites were identified for each of the three universities and for the State of Arizona by the ATRC. Surveys were mailed June 24, 1991 to these sites. On August 15 follow-up telephone calls were made to every site that had not returned a survey so as complete coverage as possible would be given. All of these sites are listed on page 32. Page numbers next to the name indicate a returned survey and a listing in this directory. In August, 1991 the Transportation Research Board sent to the ATRC a list of the private research centers the TRB had contacted. The ATRC determined that many potential private research centers were not on this list. Surveys were mailed to these sites August 15, 1991. On September 5, 1991 follow-up telephone calls were made to every site that had not returned a survey. All of these sites are listed on page 35. Page numbers next to their name indicate a returned survey and a listing in this directory. <div style="text-align: right;">Property of: ATRC Library Arizona Dept. of Transportation Arizona State University Tempe, AZ 85287</div>					
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TABLE OF CONTENTS

INTRODUCTION.....	1
ANECHOIC CHAMBERS	2
Blacktail Canyon EMI/TEMPEST Test Facility; U.S. Army	2
ElectroMagnetic Anechoic Chamber (EMAC); Arizona State University	4
CHEMICAL TESTING.....	5
Arizona Testing Laboratories	5
Emission Research Laboratory	6
CLIMATE TESTING	7
Corrosion Test Facility; Ford Motor Co.	7
Fog Chamber and High Voltage Laboratory; Arizona State University	8
Heraeus DSET Laboratories, Inc.	9
Temperature Chamber, Motorola Government Electronics Group	10
Climatic Test Chambers, U.S. Army Yuma Proving Ground	11
HYDRAULIC TESTING.....	12
Southwest Watershed Research Center; USDA	12
U.S. Water Conservation Laboratory; USDA	13
LARGE SCALE LOAD TESTING	14
Structures Laboratory; University of Arizona.....	14
MATERIALS TESTING	15
Constitutive Modelling Laboratory; University of Arizona.....	15
MICROELECTRONIC TESTING	16
Clean Room; Center for Solid State Electronics Research.....	16
Scanning Electron Microscope; Center for Solid State Electronics Research.....	17
Microelectronics Laboratory; Center for Microcontamination Control	18
SIMULATION	19
MDHC Advanced Development Center (ADC); McDonnell Douglas Helicopter Co.	19
Simulation and Systems Evaluation; McDonnell Douglas Helicopter Co.	20
TEST TRACKS	22
Mobile Dynamometer Testing; U.S. Army Yuma Proving Ground.....	22
Test Track; Ford Motor Co.	24
Tucson Proving Ground; Caterpillar Inc.	25
Vehicle Dynamic Test Surface; Ford Motor Co.....	26
Wet Traction Test Area; Ford Motor Co.	27
VIBRATION TESTING	28
Large Scale Multi-Actuator Shake Table; Arizona State University	28
Vibration Test Facility, U.S. Army Yuma Proving Ground	29
WIND TUNNELS	30
Technology Wind Tunnel; Arizona State University	30
Unsteady Wind Tunnel; Arizona State University	31
INDEXES	32
Potential Special Research Facilities in Arizona.....	32
Special Research Facilities Index - By Name	37
APPENDIX A.....	38
FHWA/TRB/AASHTO Inventory of Special Facilities for Highway Research.....	38

INTRODUCTION

In June, 1991 the Arizona Transportation Research Center (ATRC) was asked to conduct a survey for the Federal Highway Administration by the Transportation Research Board and the American Association of State Highway and Transportation Officials. This survey was to identify unique research facilities available for highway research. Computer systems were excluded. Another key criteria was that the site had to have an equipment replacement value of \$500,000 or more. The criteria for selection by the Federal Highway Administration is given in Appendix A. Potential research sites were identified for each of the three universities and for the State of Arizona by the ATRC. Surveys were mailed June 24, 1991 to these sites. On August 15 follow-up telephone calls were made to every site that had not returned a survey so as complete coverage as possible would be given. All of these sites are listed on page 32. Page numbers next to the name indicate a returned survey and a listing in this directory.

In August, 1991 the Transportation Research Board sent to the ATRC a list of the private research centers the TRB had contacted. The ATRC determined that many potential private research centers were not on this list. Surveys were mailed to these sites August 15, 1991. On September 5, 1991 follow-up telephone calls were made to every site that had not returned a survey. All of these sites are listed on page 35. Page numbers next to their name indicate a returned survey and a listing in this directory.

This directory is arranged by topic. An index by facility name is given on page 37.

TOPIC: ANECHOIC CHAMBERS

Blacktail Canyon EMI/TEMPEST Test Facility

United States Army Electronic Proving Ground
Fort Huachuca, AZ 85613-7110

Robert Weeks, Chief EMI/Tempest BR
(602)533-2818 Fax (602)533-1808

Approx. Replacement Cost: \$3 million
Staff: 12 professionals 0 support (non-clerical)

General Description:

The USAEPG EMI/TEMPEST Facility mission is to plan, conduct, evaluate, and report on EMI, TEMPEST, and IEMC tests of sophisticated electronic equipment and systems. The mission also includes the responsibility to review and/or monitor tests conducted by contractors or other agencies; and to provide EMI/TEMPEST consultant services to Project Managers as requested. EMI testing is accomplished in accordance with MIL-STD-461A, B, C/462/463; TEMPEST testing IAW NACSIM 5100A, 5112, AND KAG 30; IEMC testing IAW MIL-E-6051.

The EMI/TEMPEST facility response to testing requirements is comprised of remote facility location, secure compound area, three shielded chambers, a unique hybrid Transverse Electromagnetic/ Reverberation chamber (TEM/REV), extensive instrumentation suites, professional staffing, and active expansion efforts.

Unique Features:

1. Anechoic chamber 44'Lx22'Wx18'H with door size of 14'Hx'12'W which provides 120db of radio frequency (RF) isolation and will accommodate military gear ranging from manpack to vehicular equipments such as the HMMV, CUCV, LAV, and M113 families
2. EMI/TEMPEST shielded chamber 26'Lx15'Wx11.5'H providing 100db RF isolation
3. Shielded room 12'Lx10'Wx11.5'H providing mission testing of compact military material
4. TEM/REV chamber 12.7'Lx7.9'Wx4.3'H provides broadband RF emission and susceptibility testing of equipment. Chamber instrumentation consists of an HP8566b spectrum analyzer, HP 5400 digital oscilloscope, HP8660c signal generator, HP8350 RF oscillator, Varian TWT suite, HP438a power meter, and HP QS-20 computer and supporting peripherals which provide fully automated control of the instrumentation. (The TEM/REV chamber provides E-field immersion testing up to 3000 V/M (rms) across the 10KHz to 40GHz (Dec 91).

Capacity:

1. Three Dynamic Sciences, Inc. TEMPEST test systems providing automated testing IAW NACSIM and KAG requirements
2. Two automated AILTECH RFI/EMI data collection systems providing support to MIL-STD-461A, B, C, /462/463 radiated and conducted emission testing from 20Hz to 40GHz.
3. One each HP EMI and HP OPEN-FIELD automated systems
4. An integrated EMI susceptibility system allowing RF illumination of equipment under test from 10KHz to 40GHz at (or below) the field intensities (rms) which follow:

	<u>Current</u>	<u>Dec 91</u>
10KHz to 30MHz	100 V/M	100 V/M
30MHz to 100 MHz	100-200 V/M	200 V/M
100 MHz to 1GHz	200 V/M	200 V/M
18GHz to 40GHz	0 V/M	200 V/M

5. An extensive assortment of parallel element, rod, biconical, log periodic, double ridge guide antennae, associated RF amplifiers and electric field probes providing RF illumination and emanation detection capabilities across the 40GHz spectrum relevant to the EMI/TEMPEST arena.

Typical Projects and Uses in Past 2 Years:

Testing tracked vehicles, amphibious vehicles, and communications systems loaded on 2 ½ ton trucks or mounted in semi-vans.

Availability:

Average number of hours used per week: 40

Available for outside users: 25% of time.

Approx.. rate of charge for use: no charge.

Estimated number of comparable facilities in the U.S. and abroad: unknown

Comments:

The AILTECH EMI/RFI Data collection and Dynamic Sciences 9000 series TEMPEST systems provide portability to allow performance of on-site EMI/TEMPEST tests at various customer facilities. The Branch has traveled around the U.S. and Europe to support various customer requirements.

In response to the growing EMI/TEMPEST mission USAEPG is augmenting the existing facility with the addition of a shielded chamber for distributed systems testing 1992, and a large TEM/REV chamber FY94.

The 60'Lx25"Wx19'H shielded chamber will allow EMI/TEMPEST testing of multiple shelter systems currently tested outdoors. The chamber is under design/construction and is anticipated to be operational in the Spring of 1992.

The TEM/REV chamber provides the capability to fully immerse joint tactical aircraft and large platform systems in a uniform electric field up to 3000 V/M (rms) from 10kHz to 40GHz.

TOPIC: ANECHOIC CHAMBERS

ElectroMagnetic Anechoic Chamber (EMAC)

Telecommunications Research Center
Arizona State University
Tempe, AZ 85287-7206

Dr. Constantine A. Balanis, Regent's Professor and Director
(602)965-3909 Fax (602)965-8325

Approx. Replacement Cost: \$6 million
Staff: 1 professional 0 support (non-clerical)

General Description:

EMAC is a 2,200 square foot facility that supports the research of faculty and graduate students by providing precision antenna and radar cross section measurements. In addition, the facility is a test bed for a unique design in Compact Antenna Test Ranges (CATR).

Unique Features:

The March Microwave designed CATR is a curved, highly polished metal reflector that reshapes the spherical waves from the system's feed into high quality cylindrical wavefronts in the test region. Cylindrical wave measurements are acquired utilizing an HP 8510B Network analyzer and they are then transformed to the desired plane wave results via computer software. ASU has the distinction of being the first to implement this cylindrical wave range configuration.

Capacity:

The inside dimensions are 51'x26'x18'. 2.5m Test region; Antenna patterns; RCS patterns; ISAR imaging; Time-domain gating; S-parameters; Material properties; 0.01-20.0 GHz.

Typical Projects and Uses in Past 2 Years:

1. Advanced Antenna Research
2. Stealth Technology

Availability:

Average number of hours used per week: 30
Not available for outside users

TOPIC: CHEMICAL TESTING

Arizona Testing Laboratories

810 East Hammond Lane

Phoenix, AZ 85034

Steven Hankins, President

(602)254-6181 Fax (602)340-0473

Approx. Replacement Cost: \$1,500,000

Staff: 15 professionals 9 support (non-clerical)

General Description:

Chemical testing laboratory specializing in environmental analyses of water, wastewater, and hazardous waste. Also general chemical analyses using classical wet chemistry.

Unique Features:

Facility was designed and built as a chemistry laboratory.

Availability:

Average number of hours used per week: 70 hours

Not available for outside users.

Estimated number of comparable facilities in the U.S. and abroad: unknown

TOPIC: CHEMICAL TESTING

Emission Research Laboratory
Department of Environmental Quality
600 North 40th Street
Phoenix, AZ 85008

Frank Cox, Program Manager
(602)255-2246 Fax (602)255-1232

Approx. Replacement Cost: \$1.1 million
Staff: 2 professionals 4 support (non-clerical)

General Description:

Our laboratory is capable of performing the complete federal test procedure for new certification on emission. Using the three center bays of the vehicle emission building, we have a constant volume sampling system with both 300 and 600 cfm venturi. A ECE 50 class emission dynamometer and a sealed evaporative enclosure, also fuel cold storage and fuel chiller carts. All driving traces and analytic bench functions are computer controlled. We are capable of reading with an analytic bench, carbon monoxide (0-1.0%), Carbon Dioxide (0-5%), Total Hydrocarbon (0-1000ppm) (as propane), Methane (0-400ppm), Oxides of Nitrogen (0-1000ppm).

Capacity:

Minimum time for FTP is 19 hours and we can do two vehicles at a time - maximum 10 tests per week.

Typical Projects and Uses in Past 2 Years:

Reduction of emission (tailpipe) by using oxygenated motor fuels. Reduction of emission both tailpipe and evaporative by lowering the Reid vapor pressure of motor fuel. Tailpipe emission of vehicles using compressed natural gas as a motor fuel.

Availability:

Average number of hours used per week: 40

Not available for outside users

Estimated number of comparable facilities in the U.S.: 30 Abroad: 10

Location of comparable facilities: California, Florida, Oklahoma, Michigan, Virginia, Ohio, Colorado

TOPIC: CLIMATE TESTING

Corrosion Test Facility

Ford Motor Company
Arizona Proving Ground
P.O. Box 428
Yucca, AZ 86438

Mr. F.G. Flesche, Manager
(602)753-7261 Fax (602)753-7214

Approx.. Replacement Cost: \$1.3 million
Staff: 0 professional .5 support (non-clerical)

General Description:

Humidity/ drying chambers; 10-Pass. Car/Light Truck and 1-Heavy Truck Chamber; for acceleration salt corrosion testing

Unique Features:

Maintain test ambient temperatures at 120F + 5F and 95-100% relative humidity

Typical Projects and Uses in Past 2 Years:

Automotive testing

Availability:

Average number of hours used per week: 144

Not available for outside users [special contracts have been negotiated on occasion in support of FHA and ADOT projects]

Approx.. rate of charge for use: TBD

Estimated number of comparable facilities in the U.S.: 2 Abroad: unknown

Location of comparable facilities: Michigan (GM & Chrysler)

TOPIC: CLIMATE TESTING

Fog Chamber and High Voltage Laboratory

Electrical Engineering Department
Arizona State University
Tempe, AZ 85287-5706

Dr. R.S. Gorur; Assistant Professor
(602)965-4894 Fax (602)965-8296

Approx.. Replacement cost: \$200,000
Staff: 2 professionals 3 support (non-clerical)

General Description:

A fog chamber and a high voltage lab is being used to simulate outdoor pollution and test the integrity of insulation used for power transmission. The facility has been in operation for four years and has served the needs of basic and applied research, utilities and manufacturers.

Unique Features:

Has an on-line data acquisition system and state of the art instrumentation. Equipped with diagnostic instruments for analysis of materials.

Capacity:

Can handle 16 insulation samples at one time, can perform ac, dc and impulse tests on insulation.

Typical Projects and Uses in Past 2 Years:

Projects for SRP, BPA (DOE prime) for evaluation of insulation projects for manufacturers like 3M, GE for development of better materials.

Availability:

Average number of hours used per week: 30

Available for outside users: 50% of time

Approx.. rate of charge for use: \$40/ hour

Estimated number of comparable facilities in the U.S.: 1 Abroad:

Location of comparable facilities: Lenox, MA

Comments:

The facility has been instrumental in putting ASU on the forefront of insulation technology. Many papers have been written based on the results of the facilities. Has helped to procure research contracts of up to \$1 million in the last 4 years.

TOPIC: CLIMATE TESTING

Heraeus DSET Laboratories, Inc.

Heraeus Instruments
1850 Black Canyon Stage I
Phoenix, AZ 85027

Lawrence A. Band, Sales Manager
(602)465-7356 Fax (602)465-9409

Approx.. Replacement Cost: >\$2 million
Staff: 5 engineers 50 support (non-clerical)

General Description:
Well equipped outdoor exposure test site - arid environment

Unique Features:
Full service lab for outdoor natural accelerated or artificial exposures for environmental conditions.
Support services of optical, mechanical and thermal analysis. Civil and mechanical engineers on staff.

Capacity:
40 acre site

Typical Projects and Uses in Past 2 Years:
Testing all types of materials for arid environmental conditions.

Availability:
Average number of hours used per week: 168
Available for outside users: 100% of time
Approx.. rate of charge for use: various, depends upon requested service
Estimated number of comparable facilities in the U.S.: 0 Abroad: 1
Location of comparable facilities: Australia

TOPIC: CLIMATE TESTING

Temperature Chamber

Motorola Government Electronics Group
8201 E. McDowell Road
Scottsdale, AZ 85252

John Perkins, Mechanical Engineer [M/S H-1416]
(602)441-2178 Fax (602)441-5205

Approx.. Replacement Cost: \$600,000
Staff: 0 professional 1 support (non-clerical)

General Description:
Temperature chamber, 3000 cu feet, -54°C to +95°

Unique Features:
Digitally programmable temperature cycling up to 5°C/Minute transition rates.

Capacity:
3000 cu. ft., -54°C to +95°C, 5°C/Minute transitions

Typical Projects and Uses in Past 2 Years:
Temperature qualification testing, burn-in and environmental stress screening, long-term reliability testing.

Availability:
Average number of hours used per week: 0 to 168
Available for outside users: yes, percentage of time is unknown
Approx.. rate of charge for use: \$100/hr.
Estimated number of comparable facilities in the U.S. and Abroad: not known

TOPIC: CLIMATE TESTING

Climatic Test Chambers

U.S. Army Yuma Proving Ground
Yuma, AZ 85365

A. Kenneth Groff, C, Environmental Simulation Section
(602)328-7467 Fax (602)328-7024

Approx.. Replacement Cost:

Temperature/ humidity chambers:	\$300K each
Temperature Conditioning Chambers	\$120K each
Large Multi-purpose Environmental Chamber:	\$2.5M
Weapons Firing Chamber	\$3.5M

Staff: 3 professional 27 contractors 5 support (non-clerical)

General Description:

To conduct climatic testing at this Agency there are: seven (7) walk-in temperature/humidity chambers, size 7'Wx7'Hx12'L; thirty-four (34) trailer mounted temperature conditioning chambers, size 7'Wx7'Hx12'L; sixteen (16) stationary temperature conditioning chambers, size 7'Wx7'Hx12'L; one (1) large multi-purpose environmental chamber size 20'Wx12'Hx34'L; a Weapons Firing Environmental Chamber is being installed, size 30'Wx18'Hx45'L, with several other smaller specialized chambers for altitude, salt fog and thermal exposure capabilities.

Unique Features:

Temperature/humidity chambers have a temperature range of -100°F to 200°F, humidity from 5% to 100% in a temperature range of 60°F to 145°F; temperature conditioning chambers (trailer mounted and stationary) have a range of -100°F to 200°F; the Lange Multi-Purpose Environmental Chamber has a temperature range of -50°F to 160°F with humidity of 20% to 95% in a temperature range of 60° F to 125° F; the Weapons Firing Chamber has a temperature range of -65° F to 160° F.

Capacity:

Each chamber is equipped with temperature/ humidity recorder controller, all temperature/ humidity chambers are equipped with digital programmable controllers. Data (temperature of items or air) can be acquired with various data loggers, analyzed and reduced to plots, listings, or other presentations.

Typical Projects and Uses in Past 2 Years:

Conduct temperature humidity, long term temperature storage and preconditioning (temperature) testing of artilleries and tank munitions. Utilized large Multi-Purpose Environmental Chamber for cold start testing of Army tactical and non-tactical vehicles as well as temperature/ humidity exposure testing of vehicle and shelter systems and components. Will utilize Weapons Firing Chamber to determine performance parameters of artillery and tank weapons systems at extreme temperatures.

Availability:

Average number of hours used per week: undetermined, system utilization is based upon priority of test and mission

Available for outside users: yes, percentage of time is undetermined, utilizations based upon priority

Approx.. rate of charge for use: \$35/man-hour for DOD agencies; \$85/ man-hour for non DOD agencies

Estimated number of comparable facilities in the U.S. and abroad: unknown

TOPIC: HYDRAULIC TESTING

Southwest Watershed Research Center

United States Dept. of Agriculture
Agricultural Research Service and Cooperators
2000 E. Allen Rd.
Tucson, AZ 85719

Dr. L.J. Lane, Research Leader
(602)670-6481 Fax (602)670-6493

Approx.. Replacement Cost: \$5-10 million, \$0.5 million/year
Staff: 10 professionals 20 support (non-clerical)

General Description:

Southwest Watershed Research Center in Tucson operates the 57 square mile Walnut Gulch experimental watershed and 8 small (2-10 acre) experimental watersheds on the Santa Rita Range.

Unique Features:

Largest long-term gaged watersheds in semiarid regions.

Capacity:

Rainfall (recording) data from approx.. 90 gages and runoff from approx.. 30 flumes and weirs. Also sediment data and runoff plots.

Typical Projects and Uses in Past 2 Years:

Basic hydrology: rainfall- runoff, flood frequency, etc.; global change; monsoon 90 and 91 experiments; erosion; Wepp rainfall simulator plots; transmission losses; infiltration and recharge from streams.

Availability:

Average number of hours used per week: 40+

Available for outside users: percentage of time varies

Approx.. rate of charge for use: by cooperative agreements

Estimated number of comparable facilities in the U.S.: none Abroad: none

TOPIC: HYDRAULIC TESTING

U.S. Water Conservation Laboratory

United States Dept. of Agriculture
Agricultural Research Service
4331 E. Broadway Road
Phoenix, AZ 85040

John A. Replogle, Research Hydraulic Engineer
(602)379-4356 Fax (602)379-4355

Approx.. Replacement Cost: \$500,000
Staff: 1.5 professionals 2 support (non-clerical)

General Description:

Constant head water flow system; weight-tank calibration; tiltable glass-sided channel.
Can calibrate or study flow meters, hydraulic structures, open channel flows and pipe flows.

Unique Features:

Large flows, 50,000 lb. weigh (catch) tank.

Capacity:

15 cfs recirculating flow capacity, Calibration accuracy 0.1%± Repeatability approx.. 0.06%.

Typical Projects and Uses in Past 2 Years:

Flow meter calibration (propeller meters) by SRP; critical-flow flume calibrations to check theory;
special venturi calibrations (two basic styles).

Availability:

Average number of hours used per week: 15-25

Available for outside users: 50% of time (other state, federal)

Approx.. rate of charge for use: negotiable

Estimated number of comparable facilities in the U.S.: 2? Abroad: ?

Location of comparable facilities: University of Illinois? University of Iowa? California?

Comments:

Several labs have weigh tank calibrators but with smaller capacities. Others have high flow rate, but not precision flow measurement.

This facility combines high flow rates with precision measurement.

TOPIC: LARGE SCALE LOAD TESTING

Structures Laboratory

University of Arizona
Department of Civil Engineering and Engineering Mechanics
Building 72, Room 206
Tucson, AZ 85721

Hamid Saadatmanesh, Assistant Professor
(602)621-2148 Fax (602)621-2550

Approx.. Replacement Cost: not given
Staff: 0 professional 2 support (non-clerical)

General Description:

The Structural Engineering Laboratory of the University of Arizona is equipped with a 3-foot deep strong reaction floor covering an area of 42 feet by 32 feet with tie down points at 3 feet center-to-center spacing. Modern testing facilities, which have been recently purchased through the support from the National Science Foundation and the University of Arizona include: two hydraulic actuators each with a capacity of 110± kips, a hydraulic pump with a capacity of 23 gallons per minute, and a data acquisition and reduction system capable of reading 70 strain gages and 20 Linear Variable Differential Transducers (LVDTs). In addition, portable data acquisition equipment with 20 data channels is available in the form of an HP-3421 unit with mass storage devices. A large number of mechanical and electronic measuring devices are also available in the laboratory, such as LVDTs and dial gages with ranges from 1 to 6 inches, load cells with capacities ranging from 50 to 200 kips, a variety of hand operated hydraulic pumps and jacks with capacities ranging from 50 to 200 kips, - single and double actions, etc. Test frames and hydraulic testing machines with capacities of up to 200 kips are also available in the laboratory. Engineering Department Shop is equipped with several tool-making machines, such as a lathe, drill press, saw, etc., and is supported by two machinists and an electrician.

Typical Projects and Uses in Past 2 Years:

Large scale tests of bridge girders, building frame components, and bond tests of rebar in concrete.

Availability:

Average number of hours used per week: 20

Available for outside users: 50% of time

Approx.. rate of charge for use: [blank]

Estimated number of comparable facilities in the U.S.: 20 Abroad: ?

TOPIC: MATERIALS TESTING

Constitutive Modelling Laboratory

Dept. of Civil Engineering and Engineering Mechanics
University of Arizona
Tucson, AZ 85721

Dr. Chandra S. Desai, Regents' Professor and Director
(602)621-6569 Fax (602)621-2550

Approx.. Replacement cost: \$750,000
Staff: 2 Professionals 1 Support (non-clerical)

General Description:

Triaxial and multiaxial testing of materials (soils, concrete, asphalt) in pavements and interfaces and nondestructive testing. For constitutive modelling including entire stress-strain-strength response under static, quasistatic and cyclic (repetitive) loading. Models can allow for stresses, elastic, plastic and creep strains, damage, fracture and rutting and anisotropic behavior under different stress paths.

Unique Features:

Unique and new multiaxial, cyclic shear (for interfaces) and nondestructive (ultrasonic and acoustic) facility.

Capacity:

Loading capacities include those occurring in pavement systems.

Typical Projects and Uses in Past 2 Years:

Testing of soils, rocks, concrete and interfaces and joints under three NSF grants and two AFOSR projects. Previous research projects include DOT-University Research on Testing and Computer Modelling for Multicomponent Track Support Systems.

Availability:

Average number of hours used per week: 60 (for different devices)

Available for outside users, 25% of time.

Approx.. rate of charge for use will depend on personnel and materials needed: may range from \$100 to \$1000 per test.

Estimated 6 comparable multiaxial facilities in the U.S.; unknown foreign facilities and zero comparable cyclic interface facilities.

Comments:

The testing facilities and constitutive modelling approaches available at the Univ. of AZ are unique and not readily available elsewhere. The unified modelling approach developed allows inclusion of factors such as plastic strains, volume change (dilation), creep, stress paths, fracture and damage and anisotropy in a single framework that is much simpler than conventional approaches. Recently the FAA (DOT-TSC, Cambridge, MA) is considering the use of the facilities for material testing and modelling for Unified Pavement Design and Analysis for airport pavements.

TOPIC: MICROELECTRONIC TESTING

Clean Room

Center for Solid State Electronics Research
Arizona State University
Tempe, AZ 85287-6206

Dr. Akers, Director
(602)965-3708 Fax(602)965-8118

Approx.. Replacement Cost: \$2 million
Staff: 6 professionals 3 support (non-clerical)

General Description:

Electronic fabrication clean room and electronic testing facility.

Unique Features:

Class 100 clean room.

Typical Projects and Uses in Past 2 Years:

Development of sensor electronics.

Availability:

Average number of hours used per week: 60

Available for outside users: yes, percentage of time not given

Approx.. rate of charge for use: \$500 per day

Estimated number of comparable facilities in the U.S.: many Abroad: ?

TOPIC: MICROELECTRONIC TESTING

Scanning Electron Microscope

Center for Solid State Electronics Research
Arizona State University
Tempe, AZ 85287-6206

Stefan Myhajlenko, Research Scientist
(602)965-2697 Fax (602)965-8118

Approx.. Replacement Cost: \$600,000
Staff: 1.5 professionals 0 support (non-clerical)

General Description:

Jeol 840 scanning electron microscope equipped with energy and wavelength dispersive x-ray analysis, cathodoluminescence, electron channeling, backscatter imaging, and electron beam induced current.

Unique Features:

Low temperature (liquid helium) stage for cathodoluminescence.

Capacity:

X-ray micro-analysis

Typical Projects and Uses in Past 2 Years:

1. Micro-analysis of high voltage insulators
2. Monitoring of optical waveguide processing
3. Characterization of high temperature super-alloys
4. Analysis of ohmic contacts to gallium arsenide, indium phosphide
5. Cathodoluminescence investigations of gallium arsenide surfaces
6. EBIC characterization of Si:Ge and poly-silicon structures

Availability:

Average number of hours used per week: 30

Available for outside users: yes, percentage of time is limited, decided on individual merit

Approx.. rate of charge for use: \$150/ hour

Estimated number of comparable facilities in the U.S.: 5 Abroad: 5

Location of comparable facilities: Bell Labs, IBM, GTE Research Labs, JPL, Imperial College, RSRE, University of Berlin, Oxford

TOPIC: MICROELECTRONIC TESTING

Microelectronics Laboratory

Center for Microcontamination Control
University of Arizona
1230 East Speedway
Tucson, AZ 85721

Dr. John O'Hanlon, Center Director
(602)621-3380 Fax (602)621-8881

Approx.. Replacement Cost: Whole facility: \$2 million; Test chamber: \$100,000
Staff: ½ professional ½ support (non-clerical)

General Description:

Microelectronics/ contamination control research/ teaching laboratory.

Unique Features:

4'x4'x8'H class 1 test chamber for measuring contamination shed from people, gowns and equipment.
Includes gown-up room and computer monitor and particle counter room.

Capacity:

Clean air less than one 0.5 micrometer diameter particle per cubic foot.

Typical Projects and Uses in Past 2 Years:

Evaluation of dust shed by people, cleanroom gowns, and equipment.

Availability:

Average number of hours used per week: <1 day

Available for outside users: 80% of time (4 days)

Approx.. rate of charge for use: \$700/ day

Estimated number of comparable facilities in the U.S.: 0 Abroad: 0

Comments:

Could be extremely useful for specialty measurements of dusting and wear of materials, tribiological studies.

TOPIC: SIMULATION

MDHC Advanced Development Center (ADC)

McDonnell Douglas Helicopter Company
5000 East McDowell Road
Mesa, AZ 85205

Andrew Logan; Vice President, Advanced Product Development and Technology (APDT)
Building 530, Mail Stop B325
(602)891-6100 Fax (602)891-6003

Approx.. Replacement Cost: \$140 million
Staff: 200 professionals 150 support (non-clerical)

General Description:

This is a 14-Laboratory , 340,000 square foot facility located in Mesa Arizona. Major Laboratories relevant to the Federal Highway Administration are: Instrumentation, Mass Properties, Materials and Processes, Metrology, Material Evaluation and Quality Evaluation, Manned Simulation, and Structures and Dynamics Test. Approximately 50,000 square feet of the ADC is equipped for the development and fabrication of composite components and full scale articles. Intelligent Vehicle Highway System related expertise is found in the Flight Controls Research & Development Laboratory, Avionic Computer Systems, Manned Simulation, Crew Systems, and Artificial Intelligence Laboratory Functions of the ADC.

Unique Features:

The MDHC ADC represents a coordinated effort to house under one roof all major laboratories related to the development and test of advance vehicle and systems technologies, to include those technologies specifically involved in advanced manufacturing processes. The ADC is recognized as housing "state-of-the-art" facilities for man-in-the-loop simulation and for advanced composites.

Capacity:

Surge capability for second and third shift operations exist.

Typical Projects and Uses in Past 2 Years:

Fabrication and test of advanced vehicles including the LHX Helicopter, the MDX Helicopter, and the NOTAR Helicopter. Development and fabrication of composite assemblies for the C17 aircraft have also been accomplished.

Availability:

Average number of hours used per week: 60
Available for outside users: yes, percentage of time varies
Approx.. rate of charge for use: generally based on time and materials (direct labor plus overhead, general & administrative, and profit)
Estimated number of comparable facilities in the U.S.and abroad: unknown

Comments:

The MDHC ADC was specifically designed to house the fabrication, test and development of advanced vehicle systems and subsystems. It has been in use for that purpose over the past five years.

TOPIC: SIMULATION

Simulation and Systems Evaluation

McDonnell Douglas Helicopter Co.

5000 East McDowell Road

Mesa, AZ 85205

Mr. Lee Daniel, Manager, Simulation and Systems Evaluation

Building 531, Mail Stop C240

(602)891-6887 Fax (602)891-8335

Approx.. Replacement Cost: \$57 million

Staff: approx.. 60 professionals approx.. 35 support (operations and maintenance people)

General Description:

Three, 50-foot high bay areas support five 20-foot diameter dome simulators used for real-time, man-in-the-loop simulation of advanced air vehicle designs. Principle use has been for engineering design, test and evaluation with emphasis on man-machine interface and system integration. All simulations use modern computer image generation and display equipment which provide a high degree of realism as well as experimental control over all relevant visual factors in the operator's task environment. Systems can be networked within the facility as well as via long-haul means to other geographical locations. An automated performance measurement system supports real-time data collection and off-line analysis.

Unique Features:

A high level of visual fidelity provided through use of General Electric CompuScene IV, Evans and Sutherland ESIG-1000, and Sogitec GI-10k image generation systems. Systems have a large field of regard, head-tracked, area of interest display. The facility also contains a rapid prototyping laboratory for development of advanced controls and display system concepts.

Capacity:

Facility has ability for simultaneous support of multiple programs including simultaneous conduct of classified/proprietary and unclassified projects. Limiting facility factors are number of domes and available image generation channels. Surge capability for second and third shift operations exist.

Typical Projects and Uses in Past 2 Years:

1. Engineering and production simulation support of military (Apache, LHX) and commercial (MDX) rotorcraft systems.
2. Manned simulation support of Army Night Vision Laboratory evaluations of helicopter obstacle avoidance system design parameters.
3. Simulation support of day/night adverse weather operations (advanced sensors/ automation)
4. Night vision goggle evaluations.
5. Support of NASA - Houston for visual requirements for space station proximity operations.
6. USAF support to evaluate visual simulation requirements for effective low-level flight training.

Availability:

Average number of hours used per week: 60

Available for outside users: yes, percentage of time varies

Approx.. rate of charge for use: generally based on time and materials

Estimated number of comparable facilities in the U.S.: 1 Abroad: none

Location of comparable facilities: NASA/Ames, Moffit Field, California

Comments:

The Simulation and Systems Integration function at McDonnell Douglas Helicopter Company is an integral part of a 340,000 square foot Advanced Development Center that contains fourteen laboratories. This simulation facility is currently available to the Arizona Department of Transportation (ADOT) and to the Arizona State University's Center for Advanced Transportation and Systems Research (CATSR) as well as to the five major vehicle manufacturers' test and evaluation activities located in the Phoenix area. ADOT/CATSR proposed use of this facility as an interim National Advanced Driving Simulator and it has also been proposed for Intelligent Vehicle Highway System human factors work. Demographics of the Phoenix area make this facility ideal for the study of human factors issue of the elderly. Proximity to major industry and United States Department of Defense users of simulation facilities promotes technology transfer and the potential for joint cooperative efforts.

TOPIC: TEST TRACKS

Mobile Dynamometer Testing

United States Army Yuma Proving Ground
Yuma, AZ 85365-9110

Jay Marchant, C, Automotive Systems Engineering Branch
(602)328-6550 Fax (602)328-6501

Approx. Replacement Cost:

Temperature/ humidity chambers:	\$300K each
Temperature Conditioning Chambers	\$120K each
Large Multi-purpose Environmental Chamber:	\$2.5M
Weapons Firing Chamber	\$3.5M

Staff: 3-5 professionals 4-6 contractors 2-4 support (non-clerical)
[depending on complexity of test program]

General Description:

YPG has three Mobile Dynamometers capable of performing evaluations of tractive effort, drawbar pull, rolling resistance, towing capacity, ...of all types of light through heavy vehicles and mobile equipment. Testing conducted primarily on 2½ mile paved Dynamometer course but, all wheel drive Dynamometers are capable of supporting tests on all types of terrain including soft sand, etc.

Dynamic testing capabilities supplemented by comprehensive automotive instrumentation including ability to acquire up to 132 channels of vehicle performance data (temperatures, pressures, events, interactions, etc.) including internal operating pressures and temperatures of engines, transmissions, final drives, and dynamic (moving) temperature profiles of tires throughout their performance (weights, pressures) envelopes.

Available related support facilities include vehicle maintenance shop with 40-ton overhead crane, welding and machine shop, test vehicle scale (240,000 capacity) with ability to record separate axle and wheel loadings, 150 miles of automotive durability/ mobility test courses; and climatic chamber.

Unique Features:

Dynamometer power absorption capability in excess of 1,500 hp, all data can be recorded onboard Dynamometer of telemetry to central test control point, the Multi-Purpose Environmental Chamber has a temperature range of -50F to 160F with humidity of 20% to 95% in a temperature range of 60F to 125F.

Capacity:

Each chamber is equipped with temperature/ humidity recorder controller, all temperature/ humidity chambers are equipped with digital programmable controllers. Data (temperature of items or air) can be acquired with various data loggers, analyzed and reduced to plots, listings or other presentations.

Typical Projects and Uses in Past 2 Years:

All types of light to heavy wheeled and tracked vehicles from less than 3,000 lbs., Gross Vehicle Weight (GVW) to 230,000 lbs. (Tank Transporter with fully loaded M1A1 Abrams Battle Tank and USAF Midget Man Missile Launcher).

Availability:

Average number of hours used per week: undetermined, system utilization is based upon priority of test and mission

Available for outside users: yes, percentage of time is undetermined, utilizations based upon priority
Approx.. rate of charge for use: \$35/man-hour for DOD agencies; \$85/man-hour for non-DOD agencies
Estimated number of comparable facilities in the U.S.: 1 Abroad: none

Location of comparable facilities: Aberdeen Proving Ground, MD

TOPIC: TEST TRACKS

Test Track

Ford Motor Company
Arizona Proving Ground
P.O. Box 428
Yucca, AZ 86438

Mr. F.G. Flesche, Manager
(602)753-7261 Fax (602)753-7214

Approx.. Replacement Cost: \$5 million
Staff: .25 professional .25 support (non-clerical)

General Description:

High speed test track; asphaltic concrete; 3-lane/ 5-mile oval

Unique Features:

Maximum design (neutral) speed of 140 mph. Maximum grade in curves is 2.2%

Typical Projects and Uses in Past 2 Years:

Automotive testing

Availability:

Average number of hours used per week: 168

Not available for outside users [special contracts have been negotiated on occasion in support of FHA and ADOT projects]

Estimated number of comparable facilities in the U.S.: 12 Abroad: 2

Location of comparable facilities: Arizona, Texas, Michigan, Belgium, Germany

TOPIC: TEST TRACKS

Tucson Proving Ground

6000 W. Caterpillar Trail
Green Valley, AZ 85614

Walter Harrison, Operations Superintendent
(602)648-4621 Fax (602)648-4625

Approx.. Replacement Cost: \$20 million

Staff: 10 T&D professionals, 3 Training professionals 36 T&D support, 8 Training support

General Description:

The Tucson Proving Ground consists of two separate facilities. One is used for the test and development of Caterpillar equipment, the other is a demonstration and training center for Caterpillar equipment. The facilities are located 30 miles SW of Tucson, AZ on 6300 acres of private and state leased land. Both sites are equipped with vehicle repair facilities and state-of-the-art communication/ computer systems.

Unique Features:

Elevations range from 3200 ft. to 4400 ft. The terrain is a combination of high desert and mountain ranges. The soils include sand, several types of soil and rock.

Typical Projects and Uses in Past 2 Years:

Productivity studies on track-type tractors, wheel loaders, and hydraulic excavators. Acceleration and braking on off-highway trucks, wheel loaders on grades ranging from 0% to 20%, computer data acquisition and sound level measurement tests on various types vehicles. Demonstrations and training for Caterpillar customers and dealers from around the world.

Availability:

Average number of hours used per week: T&D site=120 hours / Training=50 hours

Not available for outside users

Estimated number of comparable facilities in the U.S.: 2 Abroad: 1

Location of comparable facilities: Peoria Proving Ground, Peoria, IL; Edwards Demonstration Site, Peoria, IL; Malaga Demonstration Site, Malaga, Spain

Comments:

There are currently no plans to lease these facilities to outside companies but future developments may deem it profitable.

TOPIC: TEST TRACKS

Vehicle Dynamic Test Surface

Ford Motor Company
Arizona Proving Ground
P.O. Box 428
Yucca, AZ 86438

Mr. F.G. Flesche, Manager
(602)753-7261 Fax (602)753-7214

Approx.. Replacement cost: \$1.5 million
Staff: 0 professional 0 support (non-clerical)

General Description:

Vehicle dynamic test surface; asphaltic concrete; for handling evaluation and steering maneuvers at high and low speeds.

Unique Features:

Trapezoidal 17.2 acres of level asphalt.

Typical Projects and Uses in Past 2 Years:

Automotive testing

Availability:

Average number of hours used per week: 48

Not available for outside users [special contracts have been negotiated on occasion in support of FHA and ADOT projects]

Estimated number of comparable facilities in the U.S.: 3 Abroad:

Location of comparable facilities: Arizona (GM-Mesa); Michigan (GM & Chrysler Proving Grounds)

TOPIC: TEST TRACKS

Wet Traction Test Area

Ford Motor Company
Arizona Proving Ground
P.O. Box 428
Yucca, AZ 86438

Mr. F.G. Flesche, Manager
(602)753-7261 Fax (602)753-7214

Approx.. Replacement Cost: \$1.2 million
Staff: 0 professional .25 support (non-clerical)

General Description:

This "H" shaped facility, in one continuous plane, encompasses four different types of surfaces (burnished concrete, troweled concrete, broomed concrete and polished pebbles). The known and repeatable friction characteristics of these surfaces makes possible a comparison of friction characteristics of tires as a function of vehicle speed and tire design.

Unique Features:

The surfaces can be watered continuously to simulate wet road tire contact conditions.

Typical Projects and Uses in Past 2 Years:

Automotive testing

Availability:

Average number of hours used per week: 48

Not available for outside users [special contracts have been negotiated on occasion in support of FHA and ADOT projects]

Approx.. rate of charge for use: TBD

Estimated number of comparable facilities in the U.S.: 6 Abroad: unknown

Location of comparable facilities: Arizona, Texas, Michigan, West Virginia

TOPIC: VIBRATION TESTING

Large Scale Multi-Actuator Shake Table

Arizona State University
Earthquake Engineering Research Laboratory
Department of Civil Engineering
ECE 5306
Tempe, AZ 85287-5306

Dr. Avi Singhal, Professor
(602)965-6901 Fax (602)965-8296

Approx.. Replacement Cost: \$600,000 plus building and floor
Staff: 2 professionals 2 support (non-clerical)

General Description:

10- 1½"x10- 1½" Multi shake tables with multi actuators, with static load capacity of 250,000 lbs. 64
Digital data collection and on line data processing. Random or earthquake digital input capabilities.

Unique Features:

Multi actuator shake tables which can test bridges with phase difference at two ends.

Capacity:

64 Channels, auto data recorder with 2.5 micro second delay time between each channel

Typical Projects and Uses in Past 2 Years:

Shock isolators, bridge bearings, beam joint tests, connections, pipelines, joints

Availability:

Average number of hours used per week: variable

Available for outside users: 10% - 80% of time

Approx.. rate of charge for use: variable

Estimated number of comparable facilities in the U.S.: 2 Abroad: 2

Location of comparable facilities: University of California, Berkeley; SUNY - New York; Beijing, China;
Tscuba City, Japan

TOPIC: VIBRATION TESTING

Vibration Test Facility

U.S. Army Yuma Proving Ground
Yuma, AZ 85365

A. Kenneth Groff, C, Environmental Simulation Section
(602)328-7467 Fax (602)328-7024

Approx.. Replacement Cost: \$7,600,000
Staff: 3 professionals 4 support (non-clerical)

General Description:

The vibration test facility consists of three Electrodynamic Vibration Systems housed in three separate buildings. The systems are designed and equipped to simulate the effects of transportation (as cargo or vehicle installed equipment) upon components, units or systems utilized by the U.S. Army.

Unique Features:

Vibration equipment can produce up to 30,000 lb force, up to 2 inch displacement, excitation of random, sinusoidal or complex (sin on random, random on random), shock impulse with data acquisition and reduction.

Capacity:

Have capability to acquire vibration test as well as on vehicle vibration data. Capability to reduce/analyze vibration data to determine characteristic for performance parameters, descriptive or translate into test criteria.

Typical Projects and Uses in Past 2 Years:

Conduct logistic and tactical vibration test of artillery and tank munitions.

Availability:

Average number of hours used per week: undetermined, system utilization is based upon priority of test and mission.

Available for outside users: yes, percentage of time is undetermined, utilizations based upon priority

Approx.. rate of charge for use: \$35/man hour for DOD agencies; \$85/man-hour for non DOD agencies

Estimated number of comparable facilities in the U.S. and abroad: unknown

TOPIC: WIND TUNNELS

Technology Wind Tunnel

Department of Aeronautical Technology
Arizona State University
Tempe, AZ 85287-6406

Dr. Ben O. Latigo, Associate Professor
(602)965-4381 Fax (602)965-8296

Approx.. Replacement Cost: \$750,000
Staff: 1 professional 1 support (non-clerical)

General Description:

Subsonic 4x3 foot wind tunnel with a maximum test section velocity of 220 ft/sec with present 75hp induction motor and Hertzell propeller fan. Operates in closed- cycle mode.

Unique Features:

Flexibility in test-section rigging for both open and closed return operations.

Capacity:

386 pc, hp 3497 dl data scanner/ acquisition and control unit; scanivalve pressure system; thermal anemometry, strain gage systems.

Typical Projects and Uses in Past 2 Years:

P. Herrick, multi-screen turbulence reduction project, 1988-1990
S. Salmirs & W. Reed, truck nose drag reduction project, 1988-1989
S. Aljabari, screen pressure loss project, 1990-1991
B. Latigo, Coanda airfoil project, 1990-1991
Student projects, 1988-1991

Availability:

Average number of hours used per week: 10
Available for outside users: 50% of time
Approx.. rate of charge for use: \$200 per hour and \$150 per day occupancy
Estimated number of comparable facilities in the U.S.: many Abroad: many
Location of comparable facilities: Colleges, NASA, Boeing, Douglas Aircraft, USAF, etc.

Comments:

Tunnel was initially developed for instruction, however, it is now in a stage where it can support R&D in many areas, viz: applied aerodynamics, highway vehicle aerodynamics, environmental studies.
There is an ongoing effort to seek funding to support applied research.

TOPIC: WIND TUNNELS

Unsteady Wind Tunnel

Arizona State University
Mechanical and Aerospace Engineering
Tempe, AZ 85287-6106

William S. Saric, Professor
(602)965-2822 Fax (602)965-1384

Approx.. Replacement Cost: \$1,500,000
Staff: 1 1/3 professional 5 support (non-clerical)

General Description:

The tunnel is a low-turbulence, closed-return facility that is equipped with a 1.4x1.4x5m (4.5x4.5x16 ft.) test section, in which oscillatory flows of air can be generated for the study of unsteady problems in low-speed aerodynamics. It can also be operated as a conventional low-turbulence wind tunnel with a steady speed range of 1 m/s to 36 m/s (3 ft/sec to 118 ft/sec) that is controlled to within 0.1%. Provision is also made for simulating gusts and lulls of varying amplitude and frontal duration and for varying the intensity and scale of the freestream turbulence. A unique design feature consists of two parallel ducts, one of which serves as a test section. The flow oscillations are controlled by a system of rotating shutters such that the oscillations produced in one duct are 180 degrees out of phase with those in the other duct. This results in an improvement in performance over that obtainable in conventional single-duct facilities. The flow in the test section can be oscillated sinusoidally over a continuous frequency range from 0.1 to 25 Hz. The amplitude of the velocity fluctuation can be varied, for example, from near zero to 100 percent of mean speed at 0.1 Hz for mean speeds up to 14 m/s (46 ft/sec). The rate at which the amplitude attenuates with increasing frequency is determined by the inherent time constant of the facility which, for the dual-duct configuration, is approximately 0.2 second. The facility is powered by a 150 hp variable speed DC motor and single-stage axial blower. A square array of shutter blades just upstream of the secondary duct serves as trim shutters for speed control in the secondary duct.

Unique Features:

Unsteady, low-turbulence flow

Capacity:

Static and dynamic pressures are made with a 1000 torr and a 10 torr, temperature-compensated transducers, MKS type 390HA-0100SP05. These are interfaced with 14 bit, MKS type 270B signal conditioners. Data-processing capabilities are provided by a MASSCOMP 5600 and a DEC 5000 mod 200.

Typical Projects and Uses in Past 2 Years:

1. Transition studies on a swept-wing model; NASA Langley Research Center
2. Transition Receptivity and Control; Air Force Office of Scientific Research
3. Unsteady Low Reynolds Number Aerodynamics; Office of Naval Research

Availability:

Average number of hours used per week: 20 hours of fan time
Available for outside users: 20% of time
Approx.. rate of charge for use: \$400/ day
Estimated number of comparable facilities in the U.S.: 0 Abroad: 0

POTENTIAL SPECIAL RESEARCH FACILITIES IN ARIZONA

ARIZONA STATE UNIVERSITY [Tempe, AZ 85287 602-965-9011/ switchboard]

Responses Included in This Directory:

ElectroMagnetic Anechoic Chamber (EMAC); Telecommunications Research Center; p. 4

Electronic Fabrication Clean Room, Center for Solid State Electronics Research; p. 16

Fog Chamber and High Voltage Laboratory; Electrical Engineering Department; p. 8

Large Scale Multi-Actuator Shake Table; Earthquake Laboratory; Department of Civil Engineering; p. 28

Scanning Electron Microscope; Center for Solid State Electronics Research; p. 17

Technology Wind Tunnel; Department of Aeronautical Technology; p. 30

Unsteady Wind Tunnel; Mechanical and Aerospace Engineering; p. 31

The following facilities were not applicable to highway research or had equipment replacement value of under \$500,000:

Arizona State Univ. Research Park

Center for Advanced Research in Transportation

Center for Energy Systems Research

Center for Research in Engineering and Applied Sciences

Center for Solid State Science

CIM Systems Research Center

Electric Power Research Laboratory

Environmental Testing Laboratory

Ion Microanalyzer; Chemistry Department

Laboratory of Climatology

Nuclear Radiation Laboratory

Office of Research Development and Administration

Supersonic Wind Tunnel

Systems Simulation Laboratory

There was no response for the following:

Center for High Resolution Electron Microscopy

NORTHERN ARIZONA UNIVERSITY [Flagstaff, AZ 86011]

Office of the Vice-President for Research [They were contacted and asked for referrals to NAU centers ; there was no response and no follow up contact was made.

UNIVERSITY OF ARIZONA [Tucson, AZ 85721 602-621-2211/switchboard]

Responses Included in This Directory:

Constitutive Modelling Laboratory, Department of Civil Engineering and Engineering Mechanics; p. 15

Microelectronics Laboratory, Center for Microcontamination Control; p. 18

Structural Engineering, Department of Civil Engineering and Engineering Mechanics; p. 14

The following facilities were not applicable to highway research or had equipment replacement value of under \$500,000:

Arizona Center for Mathematical Sciences

Arizona Mining and Mineral Resources Research Inst.

Arizona Remote Sensing Center

Arizona Transportation and Traffic Inst.

Bioresources Research Facility

Center for Separation Science

Computational Fluid Mechanics Laboratory

Computer Engineering Research Laboratory

Digital Image Analysis Laboratory (DIAL)

Electromagnetics Laboratory

Engineering Experiment Station

Environmental Engineering Laboratory

Environmental Research Laboratory

Inst. of Atmospheric Physics

Laboratory of Geomechanics

Office of Arid Lands Studies

Office of Vice President for Research

Program in Applied Mathematics

School of Medicine

Semiconductor Processing Facility

Signal Processing Laboratory

Solar and Energy Research Facility (SERF)

Strategic Metals Recovery Research Facility (SMRRF)

Water Resources Research Center

THE STATE OF ARIZONA [Phoenix, AZ 85007]

Responses Included in This Directory:

Emission Research Laboratory; Dept. of Environmental Quality; p. 6

The following facilities were not applicable to highway research or had equipment replacement value of under \$500,000:

Arizona Geological Survey

Arizona Solar Energy Office

Dept. of Mines and Mineral Resources

Dept. of Public Safety

Dept. of Water Resources

State Agricultural Laboratory

FEDERAL RESEARCH SITES [mailed by Transportation Research Board]

Responses Included in This Directory:

Electronic Proving Ground; U.S. Army [Blacktail Canyon EMI/TEMPEST Test Facility]; p. 2

Climatic Test Chambers, Yuma Proving Grounds, U.S. Army; p. 11

Mobile Dynamometer Testing; Yuma Proving Grounds; U.S. Army; p. 22

Southwest Watershed Research Center; U.S. Department of Agriculture; p. 12

U.S. Water Conservation Lab; U.S. Department of Agriculture; p. 13

Vibration Test Facility; Yuma Proving Grounds; U.S. Army; p. 29

PRIVATE COMPANIES

Responses Included in This Directory:

Advanced Development Center; McDonnell Douglas Helicopter Co.; p. 19

Arizona Testing Laboratories, Inc.; p. 5

Heraeus DSET Laboratories, Inc; p. 9

Kingman Proving Ground [Ford]; p. 7, 24, 26, 27

Simulation and Systems Evaluation; McDonnell Douglas Helicopter Co.; p. 20

Temperature Chamber; Motorola Government Electronics Group; p. 10

Tucson Proving Ground; Caterpillar, Inc.; p. 25

The following facilities were not applicable to highway research or had equipment replacement value of under \$500,000:

Advanced Propulsion, Inc.
Attn: David W. Dawson, President
2849 S. 44th Street
Phoenix, AZ 85040

AG Communication Systems [formerly GTE]
Attn: Mr. A.W. "Bud" Clay, Vice President of Research and Development
2500 W Utopia Rd
Phoenix, AZ 85027

Arizona Test Center [for Nissan]
7815 N. White Parker Rd.
Stanfield, AZ 85272

ATL Testing Laboratories
Attn: David P. Hayes, President
2922 W. Clarendon
Phoenix, AZ 85017

Chrysler Corp. Arizona Proving Ground
7602 S. 115th Avenue
Tolleson, AZ 85353

Embry-Riddle Aeronautical University
Attn: Dr. Richard Felton, Aeronautical Engineering Dept.
3200 Willow Creek Rd.
Prescott, AZ 86301

Environmental Research Laboratory
2601 E. Airport Dr.
Tucson, AZ 85706

Honeywell, Research Center

16404 N. Black Canyon Highway
Phoenix, AZ 85023

Hughes Aircraft Co.
Missile Systems Group, Tucson Division
P.O. Box 11337 (Bldg 801/LI)
Tucson, AZ 85734

Intel
Attn: Test Engineering Group
5000 W. Chandler Blvd.
Chandler, AZ 85226

Metrum [formerly Honeywell Test Instruments Division]
2320 W. Peoria Ave., Building D, Suite 133
Phoenix, AZ 85029

Motorola Semiconductor Products
5005 E. McDowell Rd.
Phoenix, AZ 85008

Volkswagen Proving Ground
7602 S. 115th Avenue
Tolleson, AZ 85353

Volvo Arizona Proving Ground
20715 West Happy Valley Road
Wittmann, AZ 85361

There was no response for the following:

General Motors Desert Proving Ground
Attn: Jack Sellers
P.O. Box 10100
Mesa, AZ 85216-0100

SPECIAL RESEARCH FACILITIES INDEX - BY NAME

Advanced Development Center; McDonnell Douglas Helicopter Co.; p. 19
Arizona Testing Laboratories, Inc.; p. 5
Blacktail Canyon EMI/TEMPEST Test Facility; p. 2
Caterpillar, Inc.; p. 25
Climatic Test Chambers, U.S. Army; p. 11
Clean Room, Center for Solid State Electronics Research; Arizona State University; p. 16
Constitutive Modelling Laboratory; University of Arizona; p. 15
Corrosion Test Facility, Ford Motor Co.; p. 7
DSET Laboratories; p. 9
ElectroMagnetic Anechoic Chamber (EMAC); Telecommunications Research Center; Arizona State University; p. 4
Electronic Proving Ground; U.S. Army; p. 2
Emission Research Laboratory; State of Arizona Department of Environmental Quality; p. 6
Fog Chamber and High Voltage Laboratory; Arizona State University; p. 8
Ford Motor Co.; p. 7, 24, 26, 27
Heraeus DSET Laboratories, Inc; p. 9
Large Scale Multi-Actuator Shake Table; Earthquake Laboratory; Department of Civil Engineering; Arizona State University; p. 28
McDonnell Douglas Helicopter Co.; p. 19, 20
Microelectronics Laboratory, Center for Microcontamination Control; University of Arizona; p. 18
Mobile Dynamometer Testing; Yuma Proving Grounds; U.S. Army; p. 22
Motorola Government Electronics Group; p. 10
Scanning Electron Microscope; Center for Solid State Electronics Research; Arizona State University; p. 17
Simulation and Systems Evaluation; McDonnell Douglas Helicopter Co.; p. 20
Southwest Watershed Research Center; U.S. Department of Agriculture; p. 12
Structural Engineering, Department of Civil Engineering and Engineering Mechanics; University of Arizona; p. 14
Technology Wind Tunnel; Department of Aeronautical Technology; Arizona State University; p. 30
Temperature Chamber; Motorola Government Electronics Group; p. 10
Test Track, Ford Motor Co.; p. 24
Tucson Proving Ground; Caterpillar, Inc.; p. 25
U.S. Army, Yuma Proving Ground; p. 11, 22, 29
U.S. Army, Electronic Proving Ground [Fort Huachuca]; p. 2
U.S. Dept. of Agriculture; p. 12, 13
U.S. Water Conservation Lab; U.S. Department of Agriculture; p. 13
Unsteady Wind Tunnel; Mechanical and Aerospace Engineering; Arizona State University; p. 31
Vehicle Dynamic Test Surface, Ford Motor Co.; p. 26
Vibration Test Facility; Yuma Proving Grounds; U.S. Army; p. 29
Wet Traction Test Area, Ford Motor Co.; p. 27

APPENDIX A

FHWA/TRB/AASHTO

INVENTORY OF SPECIAL FACILITIES FOR HIGHWAY RESEARCH

SUMMARY

The Federal Highway Administration (FHWA), with the assistance of the Transportation Research Board (TRB) and American Association of State Highway and Transportation Officials (AASHTO), is preparing an inventory of special research facilities in the United States. Special facilities are defined as equipment, testing devices, and field laboratories and test tracks that are essential to a national highway research program but are only available at very few locations due to their high costs and/or to the limited demand for such facilities. To be included in this inventory, the facility must have unique capabilities and an estimated replacement cost of over \$500,000. The inventory of existing and planned facilities will be the first step in FHWA's effort to determine the types of research facilities that are needed, either at FHWA's Turner-Fairbank Highway Research Center (TFHRC) or other locations, to provide the necessary state-of-the-art resources to conduct highway research over the next twenty years and to maintain the United States' competitive position through research and development initiatives. A TRB steering committee, with assistance from the AASHTO's Research Advisory Committee, is conducting the inventory and will prepare a report documenting the results. The report will be published by TRB and widely disseminated to government agencies and research organizations.

BACKGROUND

At the heart of the Bush Administration's National Transportation Policy is the commitment to develop a strong transportation research and technology program. To meet this need in the area of highways, the FHWA plans to make its TFHRC a world-class highway research center. Two important aspects of achieving world-class status are (1) to develop and sustain a staff who can bring the appropriate technical expertise to bear on highway problems and (2) to provide state-of-the-art equipment and laboratories. In regard to the latter, FHWA plans to identify the equipment and laboratory facilities needed to carry out highway research into the 21st century. As the first step, FHWA has requested that TRB and AASHTO assist in preparing an inventory of existing and planned special research facilities as defined in the previous section. This effort will develop a central information source of special facilities to help FHWA identify gaps where present research facilities are inadequate. This will permit future facilities to be constructed with confidence that they fill real needs and avoid unnecessary duplication of research facilities.

SCOPE

For purposes of this inventory, highway R&D is defined very broadly. It includes, but is not limited to: highway design; bridge engineering; pavement design; materials engineering and quality control; geotechnical data collection and test methods; corrosion and environmental exposure; dynamics of vehicle-pavement and vehicle-structure interaction; construction and maintenance technology; hydraulics and hydrology; air, water and noise pollution; highway safety, including human factors, vehicle control, and crash protection; and intelligent vehicle-highway systems.

While the R&D areas of interest are broadly defined, the specific types of facilities of interest are quite limited. **Special facilities to be included in this inventory are defined as research equipment, testing devices, and field laboratories and test tracks that are essential to a national highway research program but are only available at very few locations due to their high costs and/or to the limited demand for such facilities. Only facilities with unique capabilities and an estimated replacement cost of over \$500,000 should be reported.**

For the inventory to serve its primary purpose, care must be exercised to guard against including too much information. This project is limited to "special" research facilities and does not include all of the computers, soil testing devices, and other equipment commonly found in many universities and testing laboratories across the country. There is no intent to produce a comprehensive catalog of all laboratory facilities. Even well-equipped and comprehensive facilities are excluded, unless they include large scale and/or specialized test facilities similar to those listed in the next section.

The inventory includes existing facilities currently in use for highway research, as well as planned facilities that will be operational within the next few years. It also includes facilities currently used in non-highway research that may have application for highway research purposes (e.g., seismic test labs used in building research that could be adapted for highway and bridge research, a human factors simulator designed for training pilots that could be adapted to highway driving simulation, robotics research facilities with potential application to highway construction and maintenance, etc.) Facilities owned by governmental agencies, research organizations, universities, and industry are included.

EXAMPLES OF FACILITIES OF INTEREST

Following are some examples of the types of special facilities of interest. The examples are provided as guidance in defining what is meant by a "special" facility. Only facilities of similar scale and uniqueness should be reported.

Materials and Geotechnical --

1. Environmental exposure chambers (walk-in type, 3000 cu. ft. or larger) with controlled temperature and/or temperature cycling; corrosive agent exposure chambers; ultraviolet or similar capabilities.
2. Large scale centrifuge equipment (as used in geotechnical model work to exaggerate effects of gravity). One-half ton bucket or larger, with acceleration to 30g or greater.
3. Instrumented full-scale structures for soil-structure interaction studies, such as retaining walls, spread footings, pile foundations.
4. Well-equipped outdoor exposure test sites for exposure to sunlight, salt, atmosphere, air pollution, temperature extremes, etc. for the investigation of deterioration and corrosion of various materials and of the effectiveness of protective coatings, inhibitors, etc.

Pavements and Structures --

1. Large-scale structural test facilities (capable of static loads over 1 million pounds and controlled repeated and/or dynamic loads over 100,000 pounds).
2. Seismic shake tables (10 x 10 ft. or larger, with static specimen load of at least one ton), with random wave form input control and with digital data collection and processing capability.
3. Vehicle-pavement dynamic interaction simulators, with capability to carry two or more axles, and loads up to 20,000 pounds or more.
4. Pavement accelerated load test equipment and/or pavement test tracks, including those which provide control of specimen temperature and moisture.
5. Boundary layer wind tunnels (throat 8'x10' or larger), with precise control (1% of velocity in range 10 to 100 ft./sec.) and capability to generate controlled scale turbulence.

Human Factors Experimental Facilities --

1. Controlled facilities for visual experiments under special viewing conditions of fog, darkness, dust, etc.

2. Driving simulators that are interactive including kinematic cues to the subject and signing, lighting, or control devices; in-vehicle displays; or the presence of other vehicles or obstacles.

Traffic and Safety Test Facilities --

1. Test tracks capable of handling both passenger and heavy vehicles at high speeds and in critical maneuvers.
2. Crash test facilities (with adequate instrumentation and data acquisition and reduction facilities).
3. Instrumented and monitored highways for traffic control experiments.
4. Intelligent vehicle-highway test facilities.

Environmental Test Facilities --

1. Controlled facilities which permit the measurement of vehicle fuel consumption and, emissions from single or multiple vehicles under various real or simulated traffic conditions.
2. Facilities for air pollution and dispersion modeling by physical models (e.g., boundary layer wind tunnel: see above under Pavements and Structures).
3. Anechoic chambers (with 10'x10' or larger operation platform).
4. Artificial rain chambers for modeling of soil erosion and runoff coefficients of selected surfaces.
5. Large capacity hydraulic facilities for studies of open channel flow, stream bed stability and sediment transport.
6. Chambers for the evaluation of toxic hazards in the highway work environment, and for investigation of the removal, evacuation, and disposal of toxic paints and other substances encountered in bridge and highway maintenance.

Other --

The above categories are not all-inclusive; all highway research areas are included if they have facilities of the scale and cost of interest to this project.